Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	ET Docket No. 02-135
Spectrum Policy Task Force Seeks Public Comment on Issues Related to Commission's Spectrum Policies	)	

REPLY COMMENTS BY THOMAS W. HAZLETT

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That the Commission has established a Spectrum Policy Task Force is potentially a highly positive step. I describe how such an effort might work to reform public policy in the attached paper, *Liberalizing U.S. Spectrum Allocation*. It was delivered to the conference held November 9, 2001 at the AEI-Brookings Joint Center for Regulatory Studies, "Practical Steps to Spectrum Markets."

There are a few basic points I would like to briefly outline in this Reply. Elaboration is provided in my attached paper, and in a much more detailed analysis: Thomas W. Hazlett, *The Wireless Craze, the Spectrum Auction Faux Pas, the Unlimited Bandwidth Myth, and the Punchline to Ronald Coase's 'Big Joke': An Essay on Airwave Allocation Policy*, 14 HARVARD JOURNAL OF LAW & TECHNOLOGY (Spring 2001). The best version to read is here: http://www.aei.brookings.org/publications/working/working_01_02.pdf.

1. Current spectrum allocation policy is ultra-conservative, creating large social losses. Overly demanding burdens are placed on entrants, and mechanisms to force decisions or speed dispute resolution are weak. Fundamentally, the potential harm from new entry (including interference) is over-weighted, and the losses associated with delays (lessened competition, stifling of new technology) are considerably under-weighted. The Task Force will be successful if it recalibrates this process, bringing costs and benefits into balance.

2. But this does not imply that the Task Force, or the Commission, conduct the balancing. Rather, the policy goal is to reform current rules such that market participants can evaluate trade-offs in a competitive environment with rational economic feedback. Market allocation

of radio spectrum will balance the costs entailed in giving up an old service against the expected gains in trying something new.

3. The way to this market solution is not via construction, but deregulation. Rules limiting flexible use of frequencies assigned to licenses should be removed. Laws and procedures blocking access to unused or under-utilized bands by new entrants should be eliminated. With the ability to move bandwidth to where consumers most want to use it, and with profit incentives to discover where precisely those reallocation opportunities lie, tremendous efficiencies can be unleashed. This is the motive force behind the February 2001 Commission filing by "37 Concerned Economists" whose statement is a concise outline of the policy liberalization the Commission should be implementing: http://www.aei.brookings.org/publications/related/fcc.pdf.

4. The primary function of the law governing spectrum use is to allow users and service providers clear control of frequency space, with liability for damages incurred. The regulatory function is not to (a) create markets, (b) definitely settle all questions of license use or property rights; (c) find the perfect path to liberalization. The ideal is the enemy of the good, and time-to-market is the key variable in opening use of the spectrum to new competition.

5. Interference dispute resolution should not be a detailed ex ante Commission determination. This inefficiently front-loads the regulatory process, paying incumbents to debate interference issues to delay competition. The Commission should move interference dispute resolution to a liability framework, limiting pre-entry regulation to certification of entrants' ability to compensate for any potential damage inflicted on other legal owners of radio spectrum. This would stimulate cost-effective solutions for insurance, conflict resolution, and spectrum use. Establishing broad standards and general mechanisms for resolving disputes could assist this process, where detailed case-by-case analysis of predicted (or alleged) interference blocks it.

6. Deregulation is not a "windfall." Liberalization – unless confined to special friends of the Commission, which would rightfully be called something else entirely – expands social output. The public benefits include better service, access to new technology, enhanced networks, and lower prices. That these benefits are delivered by service providers who receive additional rights to use radio spectrum is both a good way to implement policy and just half the story: these same wireless operators are instantly subject to more intense competition from rivals awarded the same (expanded) rights. In an ongoing empirical investigation, I am examining prices paid at auction for cellular, PCS, or 3G licenses in twenty-three countries. In the three nations that grant substantially more expansive rights to wireless operators – permitting full flexibility as seen in a lack of service definition – we observe substantially lower license prices.[1] These results are not explained by other differences such as income, urbanization, fixed line penetration, stock market levels, or amount of spectrum allocated to wireless telephony (which itself is negatively correlated with

[1] Countries included in the sample are Argentina, Austria, Belgium, Bolivia, Brazil, Canada, Czech Republic, Denmark, Germany, Italy, Hungary, Mexico, Morocco, Netherlands, Peru, Singapore, Switzerland, U.K., and U.S.A, with Australia, Guatemala, and New Zealand the liberal spectrum regimes.

license bids). See Figure 1. This supports the view that liberal policies promote competition, resulting in negative "windfalls" for operators.

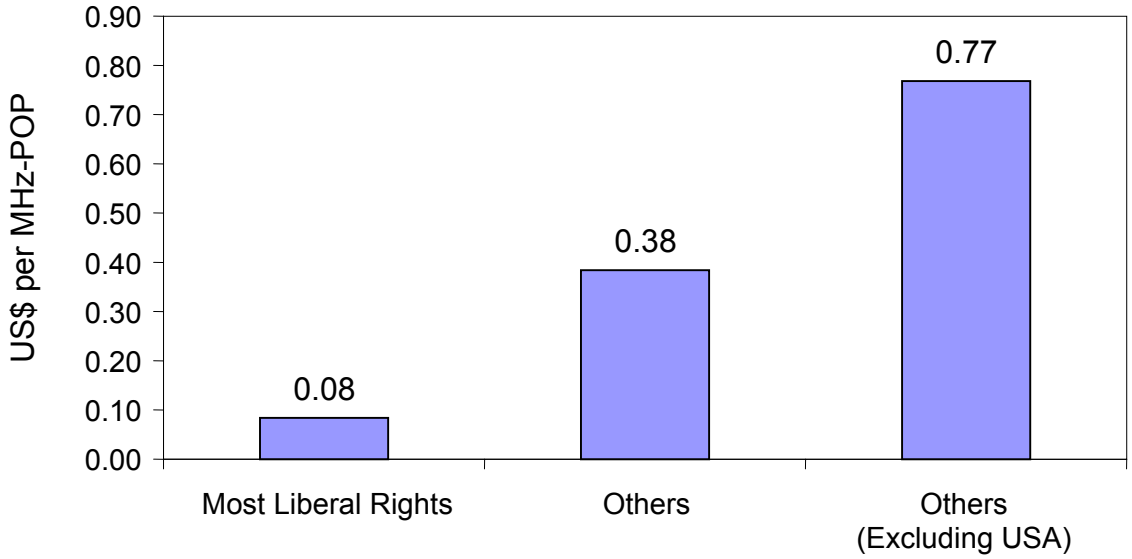

FIGURE 1. AVERAGE WINNING WIRELESS TELEPHONE LICENSE BIDS (1994-2001)

7. Broadcast television spectrum is the mother lode. The TV band is vastly underutilized and of enormous potential value to wireless competitors including fixed broadband and emerging technologies. Do not take broadcast TV spectrum "off the board" on public interest grounds; on public interest grounds the arguments are overwhelming that much greater social value would result were the airwaves to be redeployed. See Thomas W. Hazlett, *The U.S. Digital TV Transition: Time to Toss the Negroponte Switch*, Working Paper 01-15 (Nov. 2001), AEI-Brookings Joint Center for Regulatory Studies: http://www.aei.brookings.org/publications/working/working_01_15.pdf.

8. Spectrum scarcity continues to be a problem in both licensed and unlicensed uses. Minimizing coordination problems under conditions of scarcity is the goal of policy. In some instances, coordinating spectrum use takes place because other institutions – for example, ownership of real property – allows individual users to optimize local wireless networks. In others, the government is brought in to create and enforce rules, such as power limits or technical standards, to coordinate potentially conflicting uses.

9. Shared use does not have to be unlicensed. Manufacturers, technologist, entrepreneurs, and service providers have strong incentives to develop communications traffic. Given the flexibility to do so, they will discover innovative ways to accommodate diverse wireless traffic flows over given bandwidth. The most successful application of spread spectrum technology, for example, is Code Division Multiple Access via licensed broadband PCS. Thousands of users (including non-CDMA users) share frequency space via a wireless network optimized by a service provider given wide latitude to utilize the allocated band. U.S. PCS allocation policy granted licensees the right to select a technology standard; CDMA

was developed, tested, deployed and now flourishes directly as a result of that liberal regime. Flexible rights promote investment, technology, and spectrum sharing.

10. A free and competitive market in wireless bandwidth will allow entrants to gain access to users – quickly -- by paying the marginal cost of spectrum. That is the policy optimum.

Respectfully submitted (electronically),

Thomas W. Hazlett
July 18, 2002

ATTACHMENT:

Thomas W. Hazlett, *Liberalizing U.S. Spectrum Allocation*

Liberalizing U.S. Spectrum Allocation

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Revised: June 17, 2002

[2] Senior Fellow, Manhattan Institute for Policy Research, and Fellow, AEI-Brookings Joint Center on Regulatory Studies. This paper was presented to the AEI-Brookings Joint Center Conference, "Practical Steps to Spectrum Markets" (November 9, 2001). The author wishes to thank Sol Schildause for important historical information, and Bruno Viani and Lydia Regopoulos for excellent research assistance.

I. The Problem

Excess demand exists for access to radio spectrum.[3] New competitors seeking to enter wireless markets, and innovative technologies eager to test customer acceptance, champ at the bit to bid frequencies away from current employments. They are frequently willing and able to compensate those who would sacrifice today's opportunities, but are blocked from offering tomorrow's, because regulations mandate that the price of radio spectrum be zero.[4] When price controls create shortages, the marginal opportunity cost of the controlled substance actually *rises*. Our policies, which waste massive wireless bandwidth, make the next unit of spectrum deployed much too dear.

The system, however, is not broken; it is working precisely as designed. Adjudication of wireless entry under the "public interest" standard protects incumbent service providers.[5] Suppliers of rival wireless services would be much swifter to market if spectrum inputs were available for purchase. Instead, they are slowed by regulatory process. In times of dynamic economic change these barriers exact extraordinarily steep tolls.

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[3] "[S]ubstantial unmet demand for spectrum for various applications exists in many areas, including such potentially high-valued uses as broadband fixed and mobile services." Federal Communications Commission, Policy Statement, *In the Matter of Principles for Promoting the Efficient Use of Spectrum by Encouraging the Development of Secondary Markets* (Dec. 1, 2000), par. 11.

[4] A common misperception is that license auctions held by U.S. (or other) regulators are tantamount to selling spectrum. The rights issued by competitive bidding allow winners to provide particular wireless services; spectrum use is itself fixed as (exclusively) allocated by the Federal Communications Commission. A TV broadcast station, for instance, may not unilaterally decide to stop sending TV signals and instead use the frequencies allocated to its license to transmit cellular telephone calls. The effect is to fix the price of radio spectrum at zero.

[5] The legal standard under which the FCC allocates radio spectrum is "public interest, convenience, or necessity." This emanates from the Radio Act of 1927. The use of the expression "public interest" relates to this official designation for regulatory action.

Some point to ongoing reforms and pronounce allocation problems solved. Former FCC Chair Reed Hundt proclaimed: "We totally deregulated wireless."[6] The relaxation of some rules does inform our policy choices, but the current state of spectrum liberalization is analogous to a temporary experimental license issued to one low-power non-commercial user in a remote Alaskan village. General adaptation of a good idea is very far from complete.

As outlined in the "Comment by Thirty Seven Concerned Economists" submitted to the Federal Communications Commission Feb. 7, 2001,[7] policy reforms allowing private users to determine service and technology deployments will push costs down, expand usage, and spur innovation. This will improve economic efficiency and produce an array of public goods, including those emanating from the emergence of ubiquitous communications networks.

There is little debate among economists about the net benefits of liberalization because current regulations thwart efficiency without creating off-setting social benefits. Economists familiar with the current system understand that the alternative to extant regulation is neither chaos nor monopoly. Interference between users can result in a tragedy of the commons, but alternative rules can remedy boundary disputes far more quickly and reliably than "public interest" proceedings. Existing rules, moreover, create a moral hazard for incumbents who are rewarded for raising interference complaints simply to block competition. Likewise, monopoly power can arise in either current or more liberal spectrum allocation regimes, but the status quo systematically creates market power for licensees by raising barriers to entry.

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[6] Reed Hundt, YOU SAY YOU WANT A REVOLUTION (New Haven: Yale University Press, 2000), 98.

[7] See: http://www.aei.brookings.org/publications/related/fcc.pdf.

By generally reducing those barriers while allowing traditional antitrust enforcement (by the FCC or two other federal agencies, the Department of Justice and the Federal Trade Commission) to police anti-competitive conduct, economists offer that regulation may be unambiguously improved.

Despite an economic consensus in favor of liberalization, it is not obvious how to implement such policies. While the decades-long debate over license assignment has been resolved in favor of Ronald Coase's 1959 plan to utilize competitive bidding, a market in spectrum itself has yet to arrive. Indeed, the advent of license auctions may not be helping to open up access to airwaves, as there is some evidence that despite intense pressure from emerging New Economy industries, spectrum allocations in the auctions era are no more expeditious than during previous epochs. See Table 1.

There are three basic ways to move spectrum policy. The first is for the FCC to make better decisions. These decisions must not just be ultimately wiser, but more rapidly ultimate. Entry delayed is competition squandered. Second, the Commission can restructure processes, improving the procedural gauntlet entrants must brave. Third, Congress can reform the regulatory system. This paper outlines ways in which all three opportunities can improve utilization of radio spectrum.

Table 1. FCC Allocation and Auction Duration

Service	*Docket #*	*MHz*	*Petition or Event Cited as Trigger*	*Proceedings Initiated*	*Auction over*	*Total time to license (years)*
IVDS	GEN 91-2	0.5	12/2/87	1/10/91 (NPRM)	7/29/94	6.7
Narrowband PCS	GEN 90-314	3	9/22/89	6/14/90 (NOI)	7/29/94	4.8
Broad. PCS A-B	GEN 90-314	60	9/22/89	6/14/90 (NOI)	3/13/95	5.5
Broad. PCS C- F	GEN 90-314	60	9/22/89	6/14/90 (NOI)	4/15/99	9.6
DBS	IB 95 168 GEN 80-603	500	12/17/80	6/1/81 (NPPRM)	1/26/96	15.1
DARS	GEN 90-357	25	5/18/90	(8/1/90) (NOI)	4/2/97	6.9
WCS	GEN 96-228	30	8/10/95 (NTIA Rep.)	11/8/96 (NPRM)	4/25/97	1.6
LMDS # 17	CC 92-297	1300	1/91	12/10/92 (NPRM)	3/25/98	7.2
LMDS # 23 (re-auctions)	CC 92-297	1300	1/91	12/10/92 (NPRM)	5/12/99	8.3
39 GHz	ET 95-183	1400	9/9/94	12/15/95 (NPRM)	5/8/00	5.7
GWCS	ET-94-32	25	8/10/93 (OBRA)	2/10/94 (NTIA Rep.)	Auction pending	≥7
UHF Channels 60-69 (3G)	WT 99-168	24	1986	6/17/96	Auction 3/6/01	≥ 15
12 GHz terrestrial DBS	ET – 98-206	500	1994	11/19/98	Auction pending	≥ 6

Source: Thomas W. Hazlett, *The Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auction Faux Pas, and the Punchline to Ronald Coase's 'Big Joke': An Essay on Airwave Allocation Policy*, 14 HARV J L & TECH (forthcoming, Spring 2001), Table 8. Time delays calculated as of Spring 2001.

II. Permissive Licenses

To implement liberalization, the regulatory reflex is to initiate a rule making to define new license rights. But the systemic problem lies in the structure of

agency decision-making. Commission procedures require firms to receive permission to enter markets. Those permissions are not pro forma, but are complicated and idiosyncratic; standards are not fixed in advance, but vary according to the "public interest." Perhaps most importantly, entry decisions by the FCC are front-loaded, such that all possible effects of a change in spectrum use are fair game for discussion ex ante (prior to market data becoming visible). This leads to strategic gamesmanship by established interests which reliably oppose efficient, as well as interfering, entry.

Rather than explicitly constructing a market in spectrum, the preferred agency approach is to craft permissive rules that build on existing rights structures. This allows current services, and the investments that power them, to serve the public without disruption -- an efficient and politically necessary ingredient in the transition to open markets. Atop this foundation, wireless licenses should be deregulated, generically turned into broad, flexible spectrum rights.

Currently, FCC licenses wireless services as "radio station authorizations." These permits define what transmissions users can generate, the equipment used to make them, the location of such equipment, and the services they may provide. Extensive rule makings further define market structures (e.g., defining the number of competitors), channelization of allocated bandwidth, and detailed aspects of the organization licensed (for-profit, non-profit, common carrier, broadcaster, private carrier, etc.). Within this permitting process, spectrum is allocated to the license by the Commission, and its reallocation to a new purpose is not allowed.[8]

[8] Important elements of deregulation have made FCC licenses more permissive in recent years, such that the "radio station authorizations" issued allow for more flexibility on the part of the licensee. These reforms, however, have been on a case-by-case basis, releasing constraints one regulation at a time. A generic relaxation of license restrictions unleashes market activity orders of magnitude beyond these specific, measured steps.

The basic goal of liberalization is to enable markets to allocate radio spectrum, instead. Wireless licenses should be transformed from restrictive authorizations to operate equipment to permissive grants of spectrum access. Licensees should possess broad discretion to determine operating structures, technologies, standards, equipment, and the full range of standard business decisions. By allowing spectrum allocated to licenses to be used as determined by the licensee, spectrum deployment would become subject to market forces. In the normal course of maximizing profit, licensees would imaginatively attempt to squeeze additional service out of their transmissions, to economize on spectrum use, to create new services, to deploy new technologies, and to lease (or sell) bits of bandwidth to other firms with their own innovative ideas.

The argument is made that relaxation of wireless license rules results in windfall gains for licensees.[9] This springs from a view that current licensees enjoy a bundle of rights, each with an independent market value; adding extra rights unambiguously increases market value. The view is illusory in both the economic and political dimensions.

The value of additional rights for any one licensee is offset (partially, fully, or more than fully) by a reduction in the value of existing rights due to liberalization. When firms *generally* gain freedom to offer new services or technologies, the reform is a two-edged sword. They may do more, but potential competitors may do more as well. License restrictions have served as classic cartel enforcement devices, limiting the degree to which rivals may compete.[10] Elimination of such barriers to entry reduces license rents.

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[9] See: Michael Calabrese, *Principles for Spectrum Policy Reform*, New America Foundation (October 2001).

[10] Thomas W. Hazlett, *The Rationality of U.S. Regulation of the Broadcast Spectrum*, 33 J L ECON (April 1990), 133.

A firm that gains a valuable right and has few rents to protect will tend to favor more progressive policies than a firm enjoying significant rents and seeing only limited gains from spectrum flexibility. This explains why the most powerful incumbents have generally opposed spectrum liberalization (even as they occasionally submitted specific waiver requests). Only targeted reforms have been in their interest.

From the perspective of consumers, the transfers among licensees are of no consequence. Social benefits flow from the increased use of radio waves to provide service to the public. This occurs with waivers both specific and general. But allowing widespread permissiveness produces more not only than the status quo, but more than a case-by-case waiver request process.

The Commission, or statutory law, should supplant the waiver request process by adopting a general policy that non-interfering uses of frequencies allocated to licenses are legal – no matter the original service, transmission standard, station locations, or technologies mandated in the authorization. This will pre-empt the demand for license waivers. Progress should be judged not by how many new flexible rights are granted, as the Commission now touts, but by how few need be requested.

EXAMPLE: LOW POWER FM RADIO.

In the recent controversy over Low Power FM (LPFM) radio, many spectrum allocation system infirmities were exposed. In a recent paper,[11] Bruno Viani and I show that tens of thousands of community radio stations could be slotted into FM frequencies while preserving the same interference standards the FCC has observed for some decades. Such new choices for

[11] Thomas W. Hazlett and Bruno E. Viani, *Legislators v. Regulators: The Case of Low Power FM Radio*, AEI-Brookings Joint Center for Regulatory Studies Working Paper 02-1 (Feb. 2002); http://www.aei.brookings.org/publications/working/working_02_01.pdf.

listeners have been effectively stifled by the spectrum allocation process, as only trivial levels of competitive entry (under either the FCC's rule making or Congress' statutory plan, which amended the rule making) were permitted.

A more liberal result is immediately seen via a spectrum property rights approach. The FM dial, under FCC allocation rules, consists of 100 channels, each 20 KHz wide. Not all channels are licensed; within radio markets, the FCC typically leaves three adjacent channels vacant as buffers against interference. Other channels are unused because the FCC's "radio station authorization" reflects the arch-conservative nature of the "public interest" determination of spectrum usage. Were the regulatory authority, however, to simply cede each licensee control of the airspace allocated on the channels assigned for broadcasting, a new marketplace would instantly materialize.[12]

Instead of arguing for airtight interference rules barring entry, existing radio stations would aggressively compete to create low power broadcasting – and/or other services -- that fit within the confines of their existing transmissions. The new "band managers" would have profit incentives to generate new traffic, even if the sum total of such effort lowered aggregate industry profits. That is because the industry-wide agreement not to create new services, embedded in restrictive license rules, would be gone. With every broadcaster free to innovate, competition would break out. Consumers would benefit from improved access to spectrum for businesses, community organizations, educational institutions, and a wide range of speakers now silenced by Commission allocation policies. Moreover, it would move interference adjudication issues into the marketplace, as effective band

[12] Licensing all unused channels, including those reserved as buffers (perhaps granting use of these to the existing licensees they protect), is not necessary for the formation of a market in FM radio spectrum, but would surely invigorate it (i.e., drive the price of access down). See discussion in Section III.

managers search out compatible uses within their assigned bands. They would not impose zero-tolerance interference rules on spectrum they privately controlled, but would optimize the total value of traffic.

III. Allocate Bandwidth on Demand

Liberalizing existing licenses will invite wireless entry through voluntary reallocation of radio spectrum. Yet there are two additional policy actions fundamental to a pro-competitive outcome. The first involves restructuring the FCC's interference dispute resolution process, and will be discussed in the next section. The second is to allocate all new spectrum rights requested by users. Today, by categorically walling off bands to limit interference, to create "spectrum reserves," or for other purposes, the Commission (a) restricts output and wastes the spectrum resource; (b) removes incentives to create spectrally efficient systems; (c) bars experiments with innovative systems.

Take an FM radio market where 12 stations are currently licensed and 100 channels are available under the FCC's band plan. With maximum dispersal of stations, 84 channels are in "use," as each licensee consumes seven slots (an occupied channel and three buffers on either side).[13] If incumbent licensees are given control of all seven channels, each of the existing 12 licensees would be endowed with abundant frequency space with which to generate new services. In addition, 16 channels would be available for entrants. These should be issued to applicants on demand, with mutually exclusive claims assigned by competitive bidding (auctions).

The Commission should relinquish control over channel "inventories" or spectrum "reserves." Rather than withholding bandwidth from productive use

[13] Of course, 12 stations can enjoy three channel buffers in just 48 channels, if each buffer is shared. This leaves 52 channels for new claims.

to police interference or to provide for future requests, this bandwidth should be available to the marketplace. Where future users demand access to spectrum, it will be supplied by private band owners. New services, such as 3G wireless, need no regulatory approval; suppliers simply purchase spectrum access in the marketplace. These economic inputs will be priced to reflect opportunity costs, revealing the true burdens imposed and forcing tough, efficiency-enhancing choices.

Access to unoccupied bandwidth should be allowed pursuant to a request from a financially responsible party rather than a regulatory determination that harmful interference will not result.[14] Bonding or insurance requirements may be imposed on users such that damage resulting from interference is compensated, but the risk of new interference should be born by private actors rather than government administrators. Importantly, private users' liability for damage will yield efficient incentives to respect other transmissions, while de facto band ownership drives firms to fully utilize frequencies. The result is a set of incentives parallel to society's goal of maximizing the value of wireless communications.

Requested airwave rights should be quickly assigned to parties that will compete in the marketplace subject to standard contract, property, and anti-monopoly rules. Extraction of revenue should not be a goal of policy makers, as it conflicts frontally with the priority of promoting service to the public.[15] In fact, policy makers should aim for a "cheap spectrum" policy that recognizes

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[14] New rights can be assigned by priority-in-use rules, competitive bidding, or other mechanisms, although the inefficiencies of lotteries and comparative hearings are well documented. Thomas W. Hazlett and Robert J. Michaels, *The Cost of Rent Seeking: Evidence from the Cellular Telephone License Lotteries*, SO ECON J (Jan. 1993), 425.

[15] Thomas W. Hazlett, *The Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auctions Faux Pas, and the Punchline to Ronald Coase's 'Big Joke': An Essay on Airwave Allocation Policy,* 14 HARV J L & TECH (Spring 2001) ["The Wireless Craze"], Working Paper online at: http://www.aei.brookings.org/publications/working/working_01_02.pdf.

airwaves as inputs, not outputs, and correctly focuses on low-cost spectrum access as an ingredient into the formation of new communications networks.

To exhaustively license existing bands in an orderly manner, policy makers – or applicants petitioning for spectrum access – can use the concept of "overlay" rights, as used in Personal Communications Services (PCS). New licensees were allowed to use the 1850-1990 MHz band while pre-existing point-to-point microwave users continued operating. The incumbent users had priority, but could move to higher bands. Over time, these frequencies were cleared, with new users paying negotiated fees and/or moving costs to speed migration.[16]

A parallel concept of "underlay" rights can also be used to facilitate the use of low-power devices that operate in the noise floor beneath full-power devices. While such services are most often associated with unlicensed use, coordination problems – including tragedy of the commons -- arise with open entry. An alternative that retains unlicensed use and yet allows coordination between well-defined rights owners is to divvy up the noise floor into discrete parcels of bandwidth defined by frequency and power levels. Multiple (i.e., competitive) rights can be issued to parties exercising discretion over spectrum use within a given "underlay," setting standards and defining emission limits.[17] These underlay owners could then sell bandwidth to device manufacturers, service providers, networks, or other spectrum users.[18]

Creating standard mechanisms to seamlessly award spectrum rights to new wireless applications encourages entrepreneurship. Today, the creators of spectrum-based innovations must travel to market by way of the FCC's

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[16] Peter Cramton, Evan Kwerel, and John Williams, *Efficient Relocation of Spectrum Incumbents*, 41 J L & ECON (Oct. 1998), 647.

[17] See: Hazlett, *The Wireless Craze*.

[18] The most likely model is the licensing system used by patent owners. Manufacturers of communications devices could pay a band owner for access (per unit or percent of sales fee).

spectrum allocation process. This route is arduous and – in the absence of a license award – thankless. Firms must first invest in research and development, discovering new techniques or services. Then they must reveal their findings to the Commission, including proposed business plans, services to be offered, the role of key personnel, and sources of financing. Then they must initiate, monitor, and motivate one or more rule makings, enter numerous filings, arrange for expert declarations, and present a raft of factual data to accompany complex legal arguments. In some instances, applicants must enter into detailed and lengthy negotiations with the representatives of existing spectrum users, reaching frequency-sharing agreements.

These actions are costly and time-consuming, classic regulatory barriers to entry. Under the FCC's traditional licensing rules, however, there was some compensation that at least modestly offset this investment: a successful applicant gained an implicit property right to head the queue for a license, if and when it was issued. The advent of lotteries, first used for cellular licenses in 1984, removed even this return on investment, and auctions, initiated in 1994, extend that result.

In the late 1980s, Henry Geller and Donna Lampert analyzed the effect of the spectrum allocation system on entrepreneurial activity in wireless.[19] Seeing a slowing of new wireless products, it placed blame on a process that required innovators to bring "a new service or technology through the existing process... [where rivals could] 'cream skim' the best ideas and begin developing them."[20] It argued forcefully for implementation of a so-called "pioneer's preference."

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[19] Henry Geller and Donna Lampert, *In the Matter of Spectrum Allocation Decisions and New Technologies, Application for Review* (Aug. 18, 1989); cited in John Friedman, *Fostering Development of Advanced Telecommunications Technologies: The F.C.C., Pioneer's Preference & Personal Communications Services*, 12 CORDOZO ARTS & ENT L J 545 (1994) ["Friedman, *Fostering Development*"], fn 45.

[20] As summarized in Friedman, *Fostering Development*, 565.

The policy was enacted in 1991, proved an administrative disaster in PCS, and was soon abandoned.[21] But the problem it addressed remains intense. Generally opening spectrum to use by private parties would obviate this disincentive to innovation, as spectrum would be quickly available to new users at its marginal opportunity cost. But prior to overall liberalization, the Commission can institute a revised pioneer's preference system with bright-line standards, eliminating everyone-a-pioneer pleadings. When a firm clearly moves the Commission to allocate bandwidth for a service that would not exist but for the efforts of the firm, and when that result requires substantial investment in regulatory process, that firm should be rewarded with a license to compete.

EXAMPLE: NORTHPOINT TECHNOLOGY.

Northpoint Technology[22] has developed a patented system to create an extra broadband service in the direct broadcast satellite band (12.2 – 12.7 GHz). Over frequencies now shared by two existing DBS providers, Northpoint would use a hybrid network combining satellite and terrestrial wireless links to deliver about 100 channels of video programming, plus high-speed Internet access service, to residential customers across all U.S. television markets. The firm's key technical innovation is to aim transmissions to customer receiving dishes at angles that avoid disrupting reception by existing DBS subscribers.[23]

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[21] Friedman, *Fostering Development*. "[T]elecommunications consultant Chuck Jackson [states] that '(y)ou can make a good case that nobody deserved a pioneer's preference' due to strains on the FCC's administrative ability arising from determining which applicant was truly 'innovative.'" Ibid., fn 31.

[22] Not to be confused with NorthPoint Communications, a competitive local exchange carrier that filed for bankruptcy protection in 2000.

[23] See: www.broadwave.com. As described in a recent NEW YORK TIMES article: "A method for doubling the capacity of even a small part of the broadcast spectrum is

The FCC has found that the system works sufficiently well that it merits licensing. Yet, it now proposes to undertake a new rule making to create licenses for a new service -- Multichannel Video and Data Distribution Systems (MVDDS) – and auction them. In a report filed at the FCC on behalf of Northpoint in March 2001, I outlined how destructive of investment incentives for new technology this would be. Not only will it delay service provision by a minimum of three years, obliterating tax revenues (due to services not delivered) while preventing new competition,[24] it taxes innovation in other wireless markets.

The current orthodoxy is that license auctions eliminate both the inefficiencies and the political favoritism of alternative assignment methods. In the standard excess demand situation, the orthodoxy is correct: Not all claimants can be satisfied, and a rationing device must differentiate between economic bidders difficult to distinguish. Yet here, given Northpoint's singular contributions enabling the technology in question, a competition has already occurred. Imposing a new rationing device in the form of a license auction

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potentially a billion-dollar idea. As the information age has come into its own through remarkable advances in technology – which grant the right to use radio frequencies – have become the technological equivalent of Jerusalem: an overcrowded and highly desirable piece of real estate that the existing tenants and outsiders have had a difficult time sharing." Stephen Labaton, *An Earthly Idea for Doubling the Airwaves*, NY TIMES (April 8, 2001) ["NY TIMES, *An Earthly Idea.*"], 1.

[24] Such delays are extremely costly to consumers. FCC survey data show that cable television systems that face direct ("overbuilt") competition charge rates that are about 16% lower than monopoly systems on a per-channel basis. Federal Communications Commission, *Report on Cable Industry Prices***,** MM Docket No. 92-266 (Feb. 14, 2001). Northpoint Technology proposes what is, essentially, a nationwide cable overbuild. It proposes to offer a package of services that most closely resembles not DBS but cable. (This is due to its localized distribution network offering subscribers all local broadcast TV channels.) If Northpoint's entry were to reduce existing cable prices, nationwide, by an average of just five percent, consumer savings would approximate $1 billion annually. Indeed, Northpoint's business plan claims that it will offer cheaper infrastructure than that deployed by cable or satellite TV systems, and it intends to "become the Southwest Airlines of the subscription television business." NY TIMES, *An Earthly Idea.*

would appropriate the winner of that bidding process. Just as a second, sequential auction of licenses would eliminate incentives for any party to participate in the first bidding competition, so will next-generation innovators be deterred by Northpoint's appropriation.

What useful social contribution has Northpoint made? First, Northpoint discovered idle resources. According to official Commission allocation policy, the DBS band was fully deployed. There were no licenses in inventory. There were no further opportunities to assign. Through Northpoint's ingenuity, a technique for creating a third network occupying the spectrum space that accommodated just two has been created. You can read all about it in the FCC's rule making, based entirely on the technology invented by Northpoint. The Commission is generous in its footnoting of this fact.[25]

Second, Northpoint has invested not only in technology, it has expended over $10 million, 1994-2002, in an effort to move the FCC to license its system.[26] This is socially productive; only by invention *and* adoption of Northpoint's system will additional communications be delivered in existing bandwidth and will consumers have additional choices in multi-channel video subscriptions and broadband access.

To auction licenses, giving other firms equal standing to bid against Northpoint, creates two classes of free riders. Both the government and the potential licensees appropriate returns from investments made by Northpoint. The policy would send a direct message to wireless entrepreneurs: give up now.

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[25] Federal Communications Commission, *First Report and Order and Further Notice of Proposed Rule Making, In the Matter of Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range, Amendment of the Commission's Rules to Authorize Subsidiary Terrestrial Use of the 12.2-12.7 GHz Band by Direct Broadcast Satellite Licensees and Their Affiliates; and Applications of Broadwave USA, PDC Broadband Corporation, and Satellite Receivers, Ltd. to Provide a Fixed Service in the 12.2-12.7 GHz Band*, ET Docket No. 98-206, RM-9147, RM-9245 (Dec. 8, 2000).

[26] NY TIMES, *An Earthly Idea.*

This episode illustrates how a pre-occupation with government revenue extraction leads to anti-consumer policies. The argument against Northpoint's license claim is that allowing the firm to capture full value of spectrum-based services without paying for a license at auction amounts to a subsidy. As AT&T noted in its Comment submitted to the FCC: "Whatever public-interest benefits there may be to granting Northpoint its application – and AT&T submits that there are none – those benefits would not even approach the value of the spectrum and thus a grant would result in unjust enrichment."[27]

That the largest cable television operator – a firm fearing the entry of direct rivalry -- so strenuously favors competitive bidding reveals the protectionist nature of the policy as applied in this instance.[28] The "unjust enrichment" Northpoint seeks is to offer a technology that it has invented; any service the airwaves provide derive their value from the unique efforts of Northpoint.[29] Whatever enrichment flows from the business opportunity thereby created rewards Northpoint for its innovation and encourages investments in other wireless technologies.

I have suggested that the Commission adopt the following two-part test in seeking whether to assign license directly to applicants or via competitive bidding.[30] In a threshold test, it is determined whether excess demand for licenses exists. The question here is whether a request to access airwaves is

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[27] Quoted in NY TIMES, *An Earthly Idea.*

[28] AT&T serves 13.7 million cable television subscribers, one million more than the second largest cable operator, AOL Time Warner. Robert Frank and Deborah Solomon, *Bidding for AT&T Broadband Has Become More Contentious*, Wall St J (Dec. 13, 2001).

[29] To allow Northpoint a patent over its system does not solve the problem. Whatever is extracted by competitive bidding will tax the returns to creating that patent, a grant that has, in any event, a limited life that may not stretch as long as an FCC rule making.

[30] Thomas W. Hazlett, Expert Declaration submitted by Northpoint Technology to the Federal Communications Commission*, In the Matter of Applications of Northpoint USA, PDC Broadband Corporation, and Satellite Receivers, Ltd. to Provide a Fixed Service in the 12.2-12.7 GHz Band*, ET Docket No. 98-206, RM-9147, RM-9245 (March 12, 2001).

mutually incompatible with other requests filed at the same time. If requested rights are mutually exclusive, the Commission should seek to remedy the scarcity by making additional rights available in a timely fashion. Where this cannot be done, the license assignment decision moves to a second level analysis where a three-part test is employed:

a. Is the new service available specifically due to the efforts of the applicant in question? Has the party invested substantial sums in discovering, proving, and making its system compatible with other spectrum users?
b. Would license auctions substantially delay service to customers?
c. Would licensing the applicant provide an incentive for other spectrum innovators to bring new wireless applications to the marketplace?

Affirmative answers to each pillar of the test suggest that consumer welfare is advanced by awarding licenses quickly to innovative spectrum applicants.[31] Only a misapplication of the competitive bidding process would here characterize license issuance as a windfall. Auctions are designed to discover the party willing to risk the most to exploit a given business opportunity; the high bidder is seen as the efficient provider. But when the FCC's spectrum allocation process itself sponsors a competitive rivalry, wherein a firm establishes itself as the efficient provider, the auction has been held.[32] Respecting this result is crucial to economic development because it embodies the process whereby wireless technologies are discovered and implemented.

[31] Affirmative answers to fewer than three parts may be sufficient to justify a license award.

[32] Of course, liberalization – including the award of flexible rights to incumbent licensees, and applicants seeking to enter markets, such as Northpoint -- is designed to eliminate this competitive barrier. Firms will not invest substantial sums in overcoming regulatory barriers, and rewards will become moot.

IV. Interference Dispute Resolution

Limiting regulatory concerns in wireless to interference boundaries is a necessary but insufficient requirement for liberalization. Until the dispute resolution process is fundamentally reconfigured, interference claims may continue to block competitive entry. Indeed, the chief linguistic impediment to spectrum entry is the handy regulatory conversation-killer: "technical reasons."

The essential problem with interference dispute resolution at the FCC is moral hazard. Incumbents are permitted to oppose applications for new entry virtually without cost, imposing delays that often deter competition altogether. Regulatory proceedings to protest interference form an "attractive nuisance" that existing operators inevitably use to cheaply fend off newcomers who will otherwise constrain their prices and steal their market share.

The system is rigged against entrants, who shoulder the burden of proof under the public interest standard. That interference claims are heard in political forums rather than legal settings where stricter standards could limit argumentation and judges could impose time constraints, is significant.[33] And because interference claims are decided in the "public interest," rules vary from market to market, band to band. If precedents could establish law, greater certainty over standards would obtain and the scope for strategic deterrence of rivals would contract.

Another key element is that disputes over interference are front-loaded. Regulators are forced to consider highly speculative claims about technologies or service providers de novo, before actual operations begin and when

[33] The spectacle of incumbents trotting to Capitol Hill to explain issues of technical interference to congressional staffers is an apt freeze frame capturing the essence of the situation. The episode during the low-power FM radio controversy in 2000, where the National Association of Broadcasters cut CDs featuring static interference (not from actual low-power station interference, but generic interference) and handed them out to legislators and their staff members, forms a revealing self-parody.

conjectures of rival engineering experts are guaranteed (given the adversarial process) to differ sharply. Because a tie goes to the incumbent – no entry is permitted until questions are resolved – the system reliably stifles new allocation requests.

Interference, like pollution, is a by-product of output demanded by consumers. The policy aim should not be to minimize it – a common Commission misconception – but to permit the optimal amount.[34] As with other resources, there are great efficiencies in permitting decentralized market participants to discover, and trade-off, the attendant costs and benefits.

The Commission yet today opts for command and control, imposing interference limits by law that should be negotiated in the private sector. The productive alternative would allow firms to assume the risk that their emissions create harmful interference, using past Commission policies and property, tort, and contract law precedents to assess damages. FCC administrative law judges, or perhaps a newly constituted Spectrum Court, would decide interference disputes as issues of equity. Damages for radio interference would have to be proven, not simply alleged, and a potential loss of $1 would not suppress likely benefits of $1 million.

New services could be assessed, certified, and indemnified by private insurers. These agents would assume liability from harmful interference for a fee. Engineering consultants, communications law firms, equipment manufacturers, technology vendors, laboratories (such as those run by MITRE or Lucent, which today engage in testing and field evaluation for many clients, including the FCC), insurance companies, or consortia of these constituent parts would populate this market niche. Interference determined to be harmful according to prevailing standards and historical legal precedents may occur, but

anticipated benefits would compensate losses. Those with claims to radio spectrum (spectrum owners) emerge as input suppliers, striking bargains with service providers to make resources available for productive enterprise. Instead of central planners imposing a given pattern of usage and divining optimal interference levels across services, markets emerge to make rational trade-offs.[35]

EXAMPLE: MCCAIN-KERREY LPFM INTERFERENCE RESOLUTION BILL.[36]

Senators John McCain (R-AZ) and Robert Kerrey (D-NE) entered legislation in the Low Power FM (LPFM) radio debate offering an interesting reform of interference dispute resolution. To break the impasse where LPFM entrants were subjected to endless regulatory challenges, the bill authorized the FCC to place LPFM licensees in the market with safeguards to pull stations from the air that were later found to emit harmful transmissions. The measure included "expedited consideration," such that any interference complaint would come to a final decision in 150 calendar days or sooner.[37] It also contained a penalty provision for full-power stations found to be filing "frivolous" claims against LPFM stations "without any merit or purpose other than to impede the provision of non-interfering low-power FM service."

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[34] The observed Commission bias is to be overly conservative, permitting too little interference (or Type I errors). This is formally detailed in Hazlett, *The Wireless Craze*.

[35] Allowing economic agents to purchase the level of interference protection they desire is potentially of enormous importance in enhancing efficiency. This is analogous to allowing buyers to define the optimal level of energy reliability, a highly productive feature of well functioning markets, "Because consumers will vary in the extent to which they are willing to be interrupted, on what conditions, and at what prices." Vernon Smith, Stephen Rassenti, and Bart Wilson, *California: Energy Crisis or Market Design Crisis?* Paper presented to the Hoover Institution Conference on the California Electricity Crisis (Oct. 18-19, 2001), 11.

[36] The Low Power Radio Act of 2000. S. 2989, 106th Congress, 2d Session, "To provide for the technical integrity of the FM radio band, and for other purposes."

[37] The key change is role reversal: once entrants are in the market, incumbents have no interest in delaying adjudication of interference allegations.

The legislation defined "harmful interference" as "interference which… seriously degrades, obstructs, or repeatedly interrupts a radio service…." This statutory language would have to be filled in when applied by regulators or courts, which is entirely appropriate. Waiting for a perfect, absolutely general definition of interference blocks competitive entry, and delays progress on the definitional matter: real disputes, handled quickly and sensibly, best inform the general result -- namely, a body of law governing the nature, texture, and boundaries of wireless emissions.

The other subtle innovation of this policy approach is to reverse the ordering of events. Instead of all possible interference questions being heard and resolved prior to competitive entry, the entrant is permitted to commence operations. Then, when real emissions are observed and interference claims can be evaluated with actual evidence, questions of trespass are heard and expeditiously decided. The entrant takes responsibility for conflicts it causes, as it risks its investment in broadcasting and will not be compensated if shut down for causing interference. This substantial economic penalty safeguards existing transmissions from material degradation.

More importantly, the incumbent's incentive to engage in tactical delay is gone. By simply inverting the process of adjudication and entry, existing users become champions of timely enforcement. They gain nothing from stretching out processes, while demanding speedy resolution wherever actual conflicts are in evidence. Indeed, incumbents might well lobby to tighten the time limits for adjudication, strengthening safeguards for new and existing traffic. Eliminating the open-ended pre-entry debate over interference rules, and the resulting incumbent incentive for delay, constitutes substantial regulatory innovation.

V. Targets of Competitive Opportunity

Commissions acquire constituencies. These interests are serviced by the various bureaus, offices, or divisions that compose the agency. This process is spontaneous, and cannot be defeated by restricting government hiring to non-industry employees. Indeed, the FCC's Cable Services Bureau was formed in 1993 with the rule that no cable executives be eligible for employment; within two years it began to distinguish itself by issuing rulings highly favorable to the cable television industry.[38]

The FCC's old cable TV office, disbanded following deregulation in the late 1970s, offers an instructive example of how constituent service works. The FCC first sought regulatory jurisdiction over cable in the early 1960s, when broadcast TV audiences began to be "siphoned" by upstart cable operators. In a 1966 rule making that was a major triumph for the broadcasting industry, the fledgling cable industry was saddled with rules that would thwart its economic development for over a decade. A sleeper in the ruling was that a "CATV Task Force" was formed -- a consolation prize for cable interests.

The Task Force became the Cable Television Bureau in 1970, and both were headed by Sol Schildhause, previously an FCC Administrative Law Judge. Schildhause used his position to hold hearings and conduct proceedings that tended to promote cable television's visibility within the Commission. This made the costs of the FCC's anti-cable policies more apparent and controversial. The infant industry possessed scant political clout, yet over time it succeeded in rolling back key restrictions in programming, local franchising,

[38] Important pro-cable rulings came in the "going forward" rate regulation rules issued in November 1994 (signaling a major retreat from price controls imposed by the 1992 Cable Act), and the report dealing with the cable "open access" issue five years later. (*Broadband Today, A Staff Report to William E. Kennard, Chairman, Federal Communications Commission, On Industry Monitoring Sessions Convened by Cable Services Bureau*; October 1999).

and federal licensing. Having sympathetic officials at the FCC proved an important element in this deregulatory campaign.

Policy makers could today construct a Spectrum Markets Task Force. Charged with investigating the current "spectrum shortage" and intervening in various rule makings on behalf of consumers and competition, the SMTF could seek to implement generic liberalization policies, and to identify particular Targets of Opportunity.[39] Some outstanding candidates for such a list have already been presented, including Northpoint Technologies and a liberalization of the Low Power FM band. Here is another.

EXAMPLE: REDEPLOYING UHF TV SPECTRUM TO BROADBAND ACCESS.

> AccelerNet is the only company in the United States utilizing UHF television spectrum to provide high-speed Internet service. AccelerNet is the beneficiary of a recent act of the U.S. Congress: in December 2000, Congress passed landmark legislation which allows AccelerNet to provide two-way, high-speed "last mile" services utilizing low power television stations in certain cities across the United States.[40]

Sometimes it takes an act of Congress to gain permission to use the airwaves for something valuable – and sometimes an act of Congress is not enough. Consider the case of Public Law 106-554, signed by President Clinton Dec. 21, 2000.[41] It amends the Communications Act of 1934 to allow thirteen low-power TV stations to go dark, reinventing themselves as providers of two-way broadband Internet access using the same 6 MHz UHF channel assigned

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[39] It may also be advisable to appoint another FCC Administrative Law Judge as its chief, as ALJs are extremely difficult to terminate (limiting conflicts), and to mandate that the professional staff be maintained such that the following relationship obtains: E > 2 * (L + ING), where E=economist; L=Lawyer; ING=Engineer.

[40] *Legislation in Closing Days of 106th Congress Opening Digital Doors for Houston-based AccelerNet*, Press Release (Jan. 29, 2001), http://www.accelernet.net/corp/PressRelease012901.html.

[41] The law is available at: http://www.accelernet.net/corp/AccelernetLegislation.html.

their TV station.[42] The law extends the opportunity offered by a 1998 license granted AccelerNet to supply one-way fixed wireless access over the frequencies allotted low-power Channel 43, KHLM-LP, in Houston, Texas.[43]

The claims of AccelerNet in Houston are impressive. Its service competes with DSL, ISDN, cable modem, and T1 access alternatives in price and performance to both residential and business users. (See Appendix 1.) As of April 2001, the firm served over 600 commercial customers.[44] With deployment of broadband access a priority for national policy makers, with regulatory approaches to existing cable and telephone company providers provoking intense debate, and with the ensuing regulatory uncertainty spooking financial markets,[45] it would appear that a fresh competitor – a fixed wireless entrant with no market power – would be a welcome addition.

Yet a simple bureaucratic snafu has stopped the reallocation cold. In promulgating rules to permit the designated stations to begin operations, as required by the Dec. 2000 statute, the FCC slipped in a deal killer: licenses for the new wireless broadband systems would be temporary, expiring June 30, 2002. Because investors cannot amortize fixed (and sunk) capital expenses in just twelve months of operation, licensees petitioned the Commission to reconsider its policy.[46] The petitioners write: "By inserting the sunset

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[42] The stations are in Houston, Tampa, Jacksonville, Albany, Honolulu, Phoenix, Bozeman (2), Richmond, Nashville, Kenai Peninsula in Alaska, and Plano and Aurora, Illinois.

[43] Press Release (Jan. 29, 2001), http://www.accelernet.net/corp/PressRelease012901.html. The frequencies assigned KHLM are in the 640-650 MHz band. Evan Blackwell, *Changing Channels in Texas*, BROADBAND WEEK (April 2, 2001), 36, 38.

[44] Blackwell, *Changing Channels*, 38.

[45] George Bittlingmayer and Thomas W. Hazlett, *Financial Effects of Broadband Regulation,* Conference Paper, "The Broadband Economy: The Emerging Market System in Bandwidth," Columbia University (Oct. 26, 2001).

[46] Petition for Reconsiderations and Request for Expedited Consideration, *In the Matter of Implementation of LPTV Digital Data Service Pilot Project,* Federal Communications Commission (May 22, 2001). As the filing notes, the statute calls for annual fees on operators, revealing that congressional intent was clearly to establish a multi-year program.

provision in the Implementation Order, the Commission has hamstrung the pilot project and doomed it to failure." Investment is frozen while licensees attempt to secure more favorable terms through Commission pleadings, a process that could take years.

A Spectrum Markets Task Force could argue for immediate rule changes to simply extend license rights subject to interference limits (including provisions to terminate licensees creating harmful emissions). It could also promote independent agency action to expand the pilot program to include all low power UHF stations.[47] More ambitiously, it could evaluate a proposal to transfer all television programming to subscription services (i.e., cable and satellite), opening up the entire 402 MHz TV band for generic wireless telecommunications. Conservative estimates of the net social benefits of such a policy reform exceed $100 billion.[48]

VI. Challenges

In summary, the principle structural reforms enabling the emergence of spectrum markets include:

(a) Permissive airwave use within the interference contours defined by the license;

(b) Endowment of licensees with use of adjacent buffer zones;

(c) Exhaustive allocation of remaining bandwidth to new applicants;

(d) Streamlining the process whereby entrants gain access to unoccupied bandwidth, using liability rules and post-entry dispute resolution mechanisms to police interference.

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[47] Low-power TV service was established in 1982; by 1995, nearly 1,800 stations had FCC licenses: http://www.mbcnet.org/archives/etv/L/htmlL/lowpowertel/lowpowertel.htm.

Any ambitious spectrum reform proposal appears impractical, if not downright fantastic, to those of Great Experience. In a 1978 article, former Federal Communications Commission member Glenn O. Robinson outlined the argument in favor of abandoning comparative hearings in the assignment of wireless licenses.[49] His argument was compelling, but dismissed as hopelessly impractical. In an FCC ruling the previous year, in fact, two Commissioners announced the odds on adoption of either license lotteries or auctions "about the same as those on the Easter Bunny in the Preakness."[50] In his article, Robinson claimed to agree.[51]

The experts should have bet on the bunny. By 1981, lotteries were approved by Congress; in 1993 auctions were law. Yesterday's heresy, today's orthodoxy.[52] These time lags were undeniably substantial, but note that the FCC's regulatory campaign for "Advanced Television" is yet hanging by a thread, some fifteen years after its formal initiation.[53] Regulation as usual is not a reasonable alternative to serious reform, no matter the challenges. Spectrum liberalization is our one plausible strategy for progress.

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[48] Thomas W. Hazlett, *The U.S. Transition to Digital Television: Time to Toss the Negroponte Switch*, AEI-Brookings Joint Center for Regulatory Studies Working Paper No. 01-15 (Nov. 2001), http://www.aei.brookings.org/publications/working/working_01_15.pdf.

[49] Glenn O. Robinson, *The Federal Communications Commission: An Essay on Regulatory Watchdogs*, 64 VIRGINIA L R 169.

[50] Broadcast Renewal Applicant, 66 F.C.C.2d 419, 434 n.2 (1977) (Hooks & Fogarty, Comm'rs) (separate statement).

[51] Robinson, *The Federal Communications Commission*, op cit., 243.

[52] Eli Noam takes this one step further. See Noam, *Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism: Taking the Next Step to Open Spectrum Access*, 41 J L ECON 765. It goes one step too far, Tim Brennan and I argue. See Timothy Brennan: *The Spectrum as Commons: Tomorrow's Vision, Not Today's Prescription*, 41 J L ECON 791; Thomas W. Hazlett, *Spectrum Flash Dance: Eli Noam's Proposal for "Open Access" to Radio Waves*, 41 J L ECON 805.

[53] The digital television transition formally began with the initiation of a ruling making on Advanced Television in 1987. See Joel Brinkley, DEFINING VISION (Harcourt Brace, 1997).

Appendix 1. AccelerNet Broadband Services: Competitive Comparison.
Source: http://www.accelernet.net/services/index.html.

AccelerNet℠ Wireless Service	Typical Wired ISDN Service
Transport Media: Broadband Wireless downstream with an analog modem (POTS) return path Bandwidth: 512Kbps (four times the speed of a traditional hard wired 2-channel dedicated ISDN line) downstream with 14.4Kbps to 33.6Kbps upstream Monthly ISP cost: $160 PLUS Dedicated analog telphone line (Plain Old Telephone Service--POTS) $30-40 Total Monthly Charges: $190-200	Transport Media: Traditional hard wired ISDN line Bandwidth: Two channel dedicated ISDN line with 128Kbps total bandwidth Monthly ISP Charge: $200 to $400 PLUS Local loop charge for ISDN line access: $40.00 to $75.00 Total Monthly Charges: $240 to $475.00

AccelerNet℠ Wireless Service	Typical Wired T-1 Service
Transport Media: Broadband Wireless Access downstream with an ISDN return path Bandwidth: 2Mbps downstream with 128Kbps upstream Monthly ISP cost: $200 PLUS Local loop charge for ISDN line access: $40.00 to $75.00 Total Monthly Charges: $240 to $275 Total Equipment & Installation Charges: $700	Transport Media: Traditional hard wired T-1 line Bandwidth: Clear channel full duplex T-1 line with 1.544Mbps total bandwidth Monthly ISP Charge: $500.00 to $1000.00 PLUS Local loop charge for T-1 line access: $200.00 to $1000.00 Total Monthly Charges: $700.00 to $2000.00 Total Equipment & Installation Charges: $2500.00 to $8500.00